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No. 18 = ZC 3447 = A.G.C. 14880.

$\alpha = 10^h\ 48^m\ 21^s{\cdot}8$; $\delta = -58^\circ\ 12'\ 56''{\cdot}9$.

9, yellow; 12·5. bluish.

	°	″		
1897·192	217·9	3·89		blurred, hazy.
1897·193	218·3	3·29	seeing 3	
1897·192	218·1	3·59		

Although the above comparison does not indicate any very large or certain motion in the double stars of this group, I think it probable that some of the apparent changes are real. If some of the systems should be found to be in motion the result would ultimately possess a high value, as throwing light upon the connection of the stars of this cluster with the nebula in which they are projected. The region is remarkably rich in fairly close double stars, and one would naturally think that some of them at least are physical systems; but it may require ages for their motions to develope.

It had been my intention to make a very careful drawing of this great nebula, but it now seems best to defer the execution of the plan till a more convenient location of the observatory further south shall furnish more favourable conditions for a faithful delineation of its many delicate and wonderful details. It seems proper to add that when viewed with the 24-inch refractor the striking phenomena disclosed have no close resemblance to the drawings executed by Sir John Herschel, nor to the photographs recently secured by Dr. Gill. The greatly increased detail shown renders the appearance one of great complexity, and hence a really authoritative sketch will require the most favourable conditions, besides the exercise of much skill and care.

Lowell Observatory, City of Mexico:
1897 *March* 15.

The Orbit of μ Draconis. By S. W. Burnham.

As a double star this is known as Σ 2130 (= H II. 13 = Sh 242). It was discovered by Herschel I. 1779 October 17, and, as the distance was between 4″ and 8″, it was placed in his Class II. Both angle and distance were measured, and the latter recorded as 4″·354 "mean measure" (*Phil. Trans.* 1782). In his "Synopsis" of his father's double-star observations (*Mem. R.A.S.* vol. xxxv.) Herschel II. gives this distance as 4″·69, and the date a few days later than that in the original publication, and the date of the measure of the position angle as 1781·73. The latter

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would seem to be a mistake, since Herschel I. has only the single observation of 1779 October 19 in his first catalogue above referred to. There may be some warrant for this in the original MS., and for increasing the distance to 4″·69; but the smaller distance value is used in Herschel and South's Catalogue of 1824, and in the early measures of Dawes and other observers. I have used here the original values of both distance and epoch.

In 1804 Herschel recognised the angular motion, and said, "The stars being of nearly equal magnitude, we can have no inducement to suppose them to be at very different distances from us." Struve made measures of it in 1819 and 1821 before the commencement of the work recorded in *Mensuræ Micrometricæ*, and South and Herschel have a single observation in 1821. After citing the previous measures, the latter observers say: "No doubt, therefore, can remain of the reality of an angular motion in this star, as announced by Sir William Herschel in 1804; and the observations here brought together prove it to have been hitherto nearly uniform, and averaging 0°·579 per annum in the direction *npsf*, or retrograde. There can be little doubt of its being a binary system—a miniature of *α Geminorum.*"

Systematic work on this star was commenced by Struve in 1828, and since that time there is no lack of carefully made reliable mean results from measures on different nights down to the present time. The retrograde motion recognised by the early observers has steadily continued, accompanied with a slow diminution in the distance. According to Struve, the magnitudes of the components are 5·0 and 5·1.

On the accompanying diagram (Plate 18), I have given a careful selection of the best measures by the principal observers for the last hundred years. The following dates and observers are represented by complete measures of angle and distance:—

1781	1*n* ♅	1872	7*n* De
1820	2*n* Σ	1875	7*n* Du
1821	1*n* Sh	1876	3*n* Jed
1828–36 (4)	13*n* Σ	1877	8*n* Hall
1840	6*n* Da	1879	3*n* Jed
1848	1*n* Da	1883	10*n* Per, En, Jed
1855	15*n* De	1885	7*n* Hall, Per, Jed
1858	3*n* De	1886	3*n* Jed
1863	7*n* De	1888	3*n* Maw
1866	6*n* De	1889	10*n* β, Hall, Maw
1868	3*n* Du	1893	7*n* Leavenworth, Comstock
1871	11*n* OΣ, Du	1895	10*n* See, Collins, Comstock

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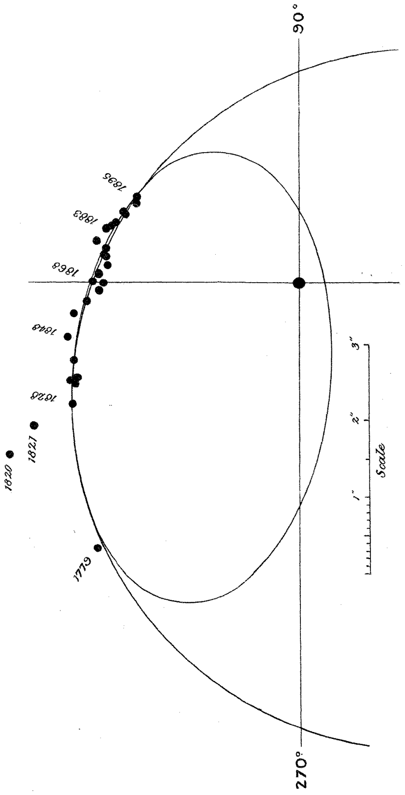

Orbit of μ Draconis.

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It is evident that the distances in the early measures of Struve, and Herschel and South, 1819 to 1821, are too large, or that the distance in 1781 is too small. The later measures of Struve appear to show that his previous measures of distance were much too large, and he seems to have considered them as not very reliable, since they are not mentioned in *Mensuræ Micrometricæ*.

One orbit has been computed for this system. Berberich (*Astr. Nach.* 2582), from an examination of the measures down to 1883, found a period of 648·0 years. As in all double stars as wide as this, and as easy of measurement, where the observed arc is short, the various measured positions are well represented by the apparent orbit; and, so far as the agreement between the observed and computed places is concerned, there is nothing for unfavourable criticism; but it is obvious enough from even a casual inspection of the diagram that the data are altogether insufficient for even the roughest approximation to the apparent ellipse and the elements of the real orbit. Indeed, as might be expected, the measures since 1883 are steadily leaving the computed positions. The chances are that the relative change will finally resolve itself into orbital motion; but, judging from the motion in the last hundred years, it will be a very long time before anything more than the bare fact of physical connection can be established, to say nothing about the details of that relation.

Doberck gives formulæ for the angles and distances (*Trans. R.I. Acad.* vol. xxvi.), and a comparison of the positions thus found with some of the measures from 1781 to 1875. For this interval the theory holds fairly well, but the measures since that time are not so well represented.

By way of showing how easily these positions are represented by orbits wholly unlike in all respects, I have given on the diagram two of the many which could be found. So far as the observed arc is concerned, these figures are practically identical, and represent all the measures down to 1883 as well as, if not better than, the computed orbit, and the six later positions are much better represented. Herschel's distance is practically perfect, and the angle requires a correction of only 2°·8, which is much less than the probable error of measures made in the last century. The ellipse with a major axis of 5″·88 gives a period of about 280 years, and the circle with a diameter of 9″·16 a period of 1,190 years, the eccentricity in the one case being 0·84, and zero in the other. Of course an almost infinite variety of conic sections could be shown which would be equally satisfactory, so far as the measures are concerned.

In 1889, with the 36-inch refractor of the Lick Observatory, I detected a third star (β 1088), exceedingly faint, at a distance of about 12″ from B. Four sets of measures have been made of this star since that time—the last in 1895—and they appear to indicate that this minute companion has the same proper motion

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as the bright stars. These measures have the following differences from the mean :—

	°	″	
1889·27	−0·2	−0·02	3*n* β
1891·30	+1·0	+0·03	3*n* β
1892·36	−0·6	+0·12	3*n* β
1895·28	−0·1	−0·13	3*n* B

These measures were all made with the 36-inch refractor, the last by Barnard in 1895. If the small star is stationary, the proper motion of the large star during the interval covered by the measures would increase the distance of C about 0″·4, and make the angle 3° less, and such a change one would expect to appear in the measures. The close agreement of the measures renders it improbable that any such change has taken place. However, the new star is a faint object even with the large aperture, and a longer interval may be necessary to establish with certainty the fact of common proper motion.